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SAFETY ANALYSIS (SA) OF THE HAZARDOUS WASTE DISPOSAL FACILITIES (BUILDINGS 514, 612, and 614) AT THE LAWRENCE LIVERMORE LABORATORY

Byron N. Odell
Arthur J. Toy

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Lawrence Livermore Laboratory

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ABSTRACT

This safety analysis was performed for the Manager of Plant Operations at LLL and fulfills the requirements of DOE Order 5481.1. The analysis was based on field inspections, document review, computer calculations, and extensive input from Waste Management personnel.

It was concluded that the quantities of materials handled do not pose undue risks on - or off-site, even in postulated severe accidents. Risks from the various hazards at these facilities vary from low to moderate as specified in DOE Order 5481.1.

Recommendations are made for additional management and technical support of waste disposal operations.

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SECTION 1 -- SUMMARY

This Safety Analysis (SA) addresses the Hazardous Waste Disposal Facilities at Lawrence Livermore Laboratory (LLL). Hazardous waste includes such things as radioactive, carcinogenic, toxic, pathogenic, pyrophoric, and flammable materials as well as pressurized containers. The hazardous waste facilities include Buildings 514, 612, and 614, as well as the tanks, incinerator, and equipment enclosed by the fenced areas surrounding these buildings. These facilities are operated by the Decontamination and Disposal Group under the Operational Safety Division of the Hazards Control Department. Replacement cost of these facilities including major equipment is over $1 000 000 (major equipment are those items worth over $500 each).

This safety analysis fulfills the requirements of DOE Order 5481.1 and apprises the Manager of Plant Operations of the safety status of these operations. Included is a description of the facilities, a discussion of their operations, an evaluation of the hazards associated with those operations, and an evaluation of the maximum credible accident.

A systematic safety analysis was performed using field inspection, document review, and computer calculations as well as extensive input from the Waste Management personnel.

This analysis determined that insufficient quantities of radioactive materials are handled to qualify these buildings as nuclear facilities as defined in DOEM 0531. Even in the event of a maximum credible accident, the off-site dose will not exceed the 500 mrem annual effluent dose limit specified in DOEM 0524.

Risks from the various hazards at these facilities vary from low to moderate as specified in DOE Order 5481.1. The moderate hazards are those that involve TRU materials and toxic chemicals at Bldg. 612 and the carboys and tanks containing radioactivity at Bldg. 514.

It is also determined from this safety analysis that, with additional management and technical support, the operations in these facilities can be conducted according to existing codes, standards, and regulations, and that there will be no undue or unusual risks to the health and safety of the public or LLL employees. Since waste is generated many places at LLL and eventually disposed of off-site, the findings and recommendations are not limited to the B514, B612, and B614 areas. They also include places where the waste is generated, picked up, delivered to Waste Disposal, and transported to a permanent waste disposal facility.

SECTIONS 2 -- FACILITY DESCRIPTIONS

BUILDING 514 AREA DESCRIPTION

General

Building 514 was constructed in 1943 by the U. S. Navy as an engine test facility and then used by LLL for solid waste disposal. In 1960, it was converted into a treatment facility for large-volume, low-level, radioactive liquid waste. The 2800-m^2 fence enclosed yard area is surfaced with asphalt and cement.

Most of the liquid is handled outside of the building in six, 7000 liter treatment tanks. The base of these tanks is surrounded by a concrete berm capable of retaining the contents of one tank in case a leak occurs. This berm drains into a sump that can be valved either to the sanitary sewer or to the treatment tanks. (See Fig 2-1 for a plot plan of the Bldg 514 area.) There are two, 123 000 liter surge tanks that are normally held in reserve to temporarily store liquid waste when all of the treatment tanks are being used. A berm, capable of retaining the content of one of these tanks, surrounds the base of these two tanks. This berm connects, by a manual valve, to a small sump located just south of the building. This sump is normally pumped to the storm drains but its contents may be held for transfer to retention tanks.

All of the treatment tanks are interconnected by a series of pipes and remotely operated valves so that the liquids can be readily pumped from one tank to another during the treatment process. Lesser tanks containing chemicals can also be pumped to the treatment tanks.

An ion exchange column stands just south of Building 514. Next to the ion exchange column is a wiped-film evaporator that is under construction.

The remote controls to operate the various pumps, stirrers, and valves for the waste treatment process are located inside Building 514 in Room 101. (See Fig. 2-2 for a plan view of the building.)

The basic machine presently used in conjunction with the treatment tanks to decontaminate the liquid is the diatomaceous-earth, rotary drum filter located in Room 108. Numerous controls, indicators, pumps, a diatomaceous earth mixer, and a sump are also located in Room 108. Various pipes extend throughout the room and are low enough to present a potential head knocker problem to the operator. A shower, change room, and toilet are located in Room 112. An unused water boiler stands in a room just north of Room 112. Various shop equipment is housed in Room 105. The office area, chemistry hood, sink, and storage is housed in Room 107.

Located just west of Bldg 514 are three underground sump tanks with lift pumps. The two southernmost tanks are interconnected and are used to retain liquids received from the sump in Room 108, from the toilet and shower, from the treatment tanks, and from the sump beneath the treatment tanks. The northern most sump collects liquid from the hood and sink located in Room 107 and from other places on the LLL site. The contents of these tanks can be pumped to the sanitary sewer after sampling for radioactivity and toxic chemicals.

Building 514 Structure

Building 514 is a concrete structure. The 200-m^2 floor area is shown in its present configuration in Fig. 2-2. The surface of the floors in Rooms 108 and 112 have been painted with a polyamide cured epoxy in order to make decontamination easier.

Personnel and Environmental Protection

Ventilation - A hood in the office area is sometimes used for chemistry. This hood is vented through the roof. Air flow is adequate for this operation and is tested routinely. Bags containing diatomaceous earth are opened in the rotary drum area of Room 108. This creates a lot of nuisance dust.

Effluent Systems and Controls - No gaseous wastes are presently being generated at the facility. However, a wiped-film evaporator has been partially constructed. When it comes on line, its gaseous effluent will be discharged through a stack subject to the restrictions of DOEM 0524 and the Bay Area Air Quality Management District. This and similar future operations are more fully described in Section 3.

Liquid waste received from various facilities on the LLL site are transferred into tanks for treatment. After being decontaminated to below LLL sewer discharge guidelines, this liquid is released to the sanitary sewer. These sewer discharge guidelines are listed in Table 2-1.

Solid waste, primarily obtained from the rotary drum filter, is collected in barrels that are then sent to the Building 612 area; see Section 3 for further details.

The nonradioactive chemicals are pumped from carboys into drums that are sent to Building 612. Presently, carboys containing radioactive liquids are being stored at Building 514 until the wiped-film evaporator is completed to properly dispose of them.

Eye Wash and Emergency Showers -- Three eye wash and emergency shower units are provided near the treatment tanks and another one is located just south of the building.

Fire Protection

Since the majority of the facility and equipment is either concrete or metal and has a low fire loss potential, it has been determined that sprinklers are not required. Sufficient fire extinguishers and fire hydrants are provided.

Safety Alarm/Alert Systems

The facility contains telephones in the Office Room 107, in the Control Room 101, in the rotary drum area Room 108, and up on the platform by the treatment tanks. High liquid level alarms are installed in Room 108 and on the treatment tanks. A disaster page alarm system has a speaker in Room 108. This one-way, Laboratory-wide system can be activated from the Emergency Control Center at the Fire Station or Police Station.

Utilities

Electric Utilities - Electric power can be delivered to this facility by any one of three systems. The high reliability of this redundant, voltage-regulated primary power and the lack of critical ventilation requirements obviates the need for emergency generators at this facility.

Piped Utilities - City water is available at a number of hose bibs, the sink, and the emergency deluge showers. This water is also used to cool the bearings of the vacuum pump for the diatomaceous earth, rotary drum filter. If the water is shut off, this pump will burn up unless it is shut down. It is recommended that an automatic shut-off be installed to remove power from this pump when the water is shut-off. A specially designed back flow prevention system has been incorporated into this facility to prevent contamination of the potable water supply.

Natural gas is used to fire the space heaters and is available at several places in the building.

Compressed air is supplied at up to 700 kPa and is used to operate hand tools such as impact wrenches.

BUILDING 612 AREA DESCRIPTION

General

Building 612 was constructed in 1965 to package LLL generated solid radioactive waste and toxic waste for shipment. Activities involving the packaging, storage, and shipment of wastes are conducted in Building 612, in the adjacent open yard area, and in Building 614. Waste containing suspected carcinogens and trace quantities of tritium is disposed of in the incinerator that is being operated under a permit from the Bay Area Air Pollution Control District. The 11200-m^2, fence-enclosed yard area is almost entirely blacktopped except for the north end, which will be blacktopped in the near future.

Building 612 Structure

The 500 m^2 floor area of the building is divided as follows (see Fig 2-3):

High bay - 400 m^2

Mechanical equipment room - 17 m^2

Mezzanine storage - 34 m^2

Laboratory, office, and washroom - 49 m^2

The total volume of the structure is approximately 2800 m^3.

The walls are either steel-reinforced concrete block or ribbed aluminum panels on steel beams. There are roll-up doors in the south and east walls. The load-bearing walls are set on spread footings.

The floor is reinforced concrete. The floor areas in Rooms 100, 104, and 105 are covered with epoxy paint to make decontamination easier. The floor of Room 100 has three, 1.5-m deep cylindrical pits that are 2.1-m in dia. These pits hold the 5.6 m^3 steel tanks (Bennett Buckets) that are used as shipping containers. When positioned in the pits, the top of these containers are less than waist high, thus making them convenient to fill. These containers are moved about by a 4500 kg hoist that runs east-west on a rail bolted to the steel roof beams.

A mezzaine, extending over Rooms 101, 102, and 103, is used as a storage area for nonradioactive materials.

The wood framed roof is supported by structural steel and concrete block walls. It is sheathed with 10-mm-thick plywood. A multilayer asphalt water proofing system surfaced with aggregate completes the roof. Personnel doors are hollow metal with glass or louver panels.

Personnel and Environmental Protection

Waste Press - The northwest corner area of Room 100 is used to hydraulically compact dry radioactive waste inside 210 liter drums. A stainless steel hood shroud follows the pressure plate and collects potentially contaminated particles. A flexible hose transports these particles to a HEPA filter with the aid of a 14 m^3/min blower. After filtration the air is exhausted through a 1-m stack on the facility roof. During this analysis, we found that the interlocks on the shielding doors of the waste press did not work properly. They have been repaired so that the press will not operate unless the shields are in place. At times, the amount of radioactive waste compressed in the press exceeds LLL guidelines for this operation. Although no detectable radioactivity has been released by this practice, it is recommended that the waste press operation be upgraded to conform to the LLL guidelines.

Slot Hood - The east wall of Room 105 has a hood capable of exhausting 170 m^3/min through a roof-mounted redundant series of HEPA filters. The discharge stacks are monitored for radioactivity during use.

Lighting - A combination of fluorescent and incandescent light fixtures are employed to provide intensities of 1000 lx in Rooms 102, 103, 104 and 105 and 500 lx in the equipment room and high-bay Room 100. The work stations in Room 100 depend primarily on the north window wall to provide adequate illumination. No exterior building lighting is provided.

Containers of over-aged ethers and other solvents that may have autoxidized to form shock sensitive peroxides are opened remotely outside of Bldg 612 and allowed to evaporate. The total volume is less than 30 liters per year.

Liquid wastes are often sent to Building 612 but the operation of this facility does not generate toxic or radioactive liquid waste. The facility has a series of floor drains that flow into a common sump. Normally, the sump is pumped directly to the sanitary sewer. In the event of a spill and washdown, the sump discharge can be valved off and it contents pumped into a portable tank that can be hauled to Building 514 area.

Nonradioactive liquid chemical wastes are temporarily stored in the 612 area awaiting shipment off-site to a disposal contractor.

The packaging operation for solid waste, in itself, creates only small amounts of dry waste. Some plastic sheets, gloves, and calcined clay are used in packaging. Only one container, the concrete block, adds appreciably to the waste bulk. The waste packages and their contents will be discussed in detail in Section 3.

Fire Protection

A sprinkler system throughout Building 612 has sprinkler heads spaced at a maximum of 9 m^2/head. These heads are individually activated by heat and the automatic system transmits an alarm to the Fire Station when the sprinklers are activated. There is a spray damper on the exhaust of the slot hood in Room 105. Sufficient fire extinguishers and fire hydrants are provided.

Safety Alarm/Alert Systems

The facility contains telephones in the Office Room 104, in the northwest area of Room 100, and in the southeast outside corner of the building. The Paging and Disaster Alarm System at Bldg 612 is a one-way Laboratory-wide system that can be activated from the Emergency Control Center at the Fire Station or Police Station.

Utilities

Electric Utilities - Electric power can be delivered to this facility by any one of three systems. Because the loss of power to exhaust fans could cause personnel and building contamination, there should be an emergency generator that starts up automatically whenever the primary power sources fail.

Piped Utilities - City water is available at a number of hose bibs in the high-bay Room 100 and at two emergency deluge showers. The automatic fire-suppression sprinkler system uses city water and has a separate feeder line into the building.

Natural gas is used to provide space heat in Rooms 102 and 104, and hot water in the equipment room.

Compressed air is supplied at up to 700 kPa, and is used to operate hand tools such as impact wrenches.

BUILDING 614 AREA DESCRIPTION

Building 614 is in the same area as Building 612. It is a one-story, three-sided, concrete-block structure that is open on the east side and divided into four storage bays. The building is 12 m x 4 m and is 4 m high (see Fig. 2-4). It is used to store equipment and supplies that are used in treating waste in Building 612 as well as chemicals that are awaiting disposal. The only utilities that exist in this structure are water and lights. No one occupies the building.

Table 2-1. LLL Sewer Discharge Guidelines

Contaminant	Limit	Comment
α	26 pCi/ℓ not to exceed 5 μCi/d	As low as reasonably achievable (ALARA); DOE limit is 45 μCi/d
β	260 pCi/ℓ not to exceed 50 μCi/d	ALARA; DOE limit is 150 μCi/d
HTO	20 mCi/d	ALARA; DOE limit is 4.5 Ci/d
Be	2 mg/ℓ	
Cr(VI)	100 mg/ℓ	Combination of Cr(VI), Cu, Zn, Ni must be less than 100 mg/ℓ
Cu	10 mg/ℓ	
Zn	50 mg/ℓ	
Ni	10 mg/ℓ	
pH	6.8 - 8.0	
TDS	325 mg/ℓ greater than incoming water	TDS means total dissolved solids

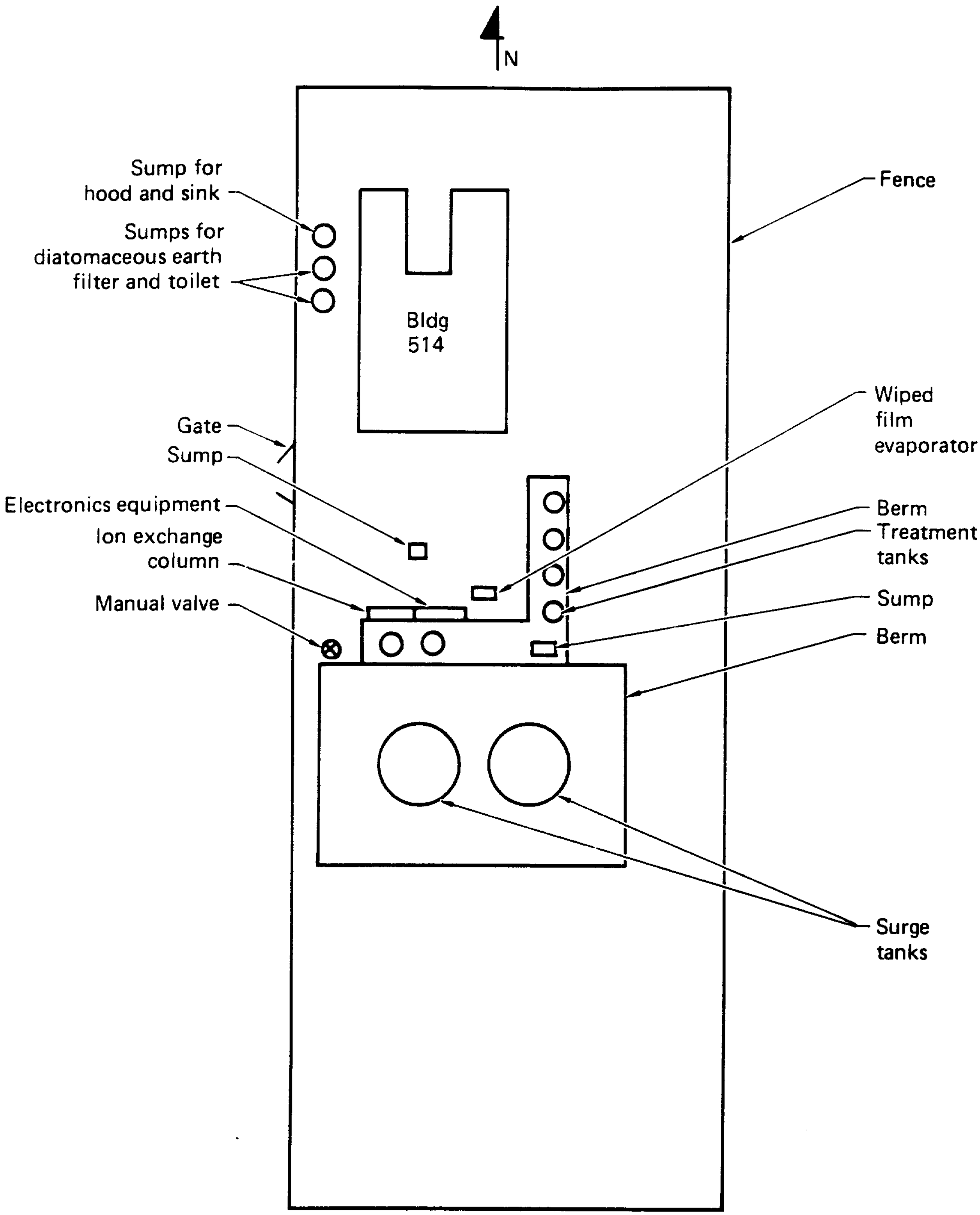


Fig. 2-1 Plot Plan of the Bldg 514 Area

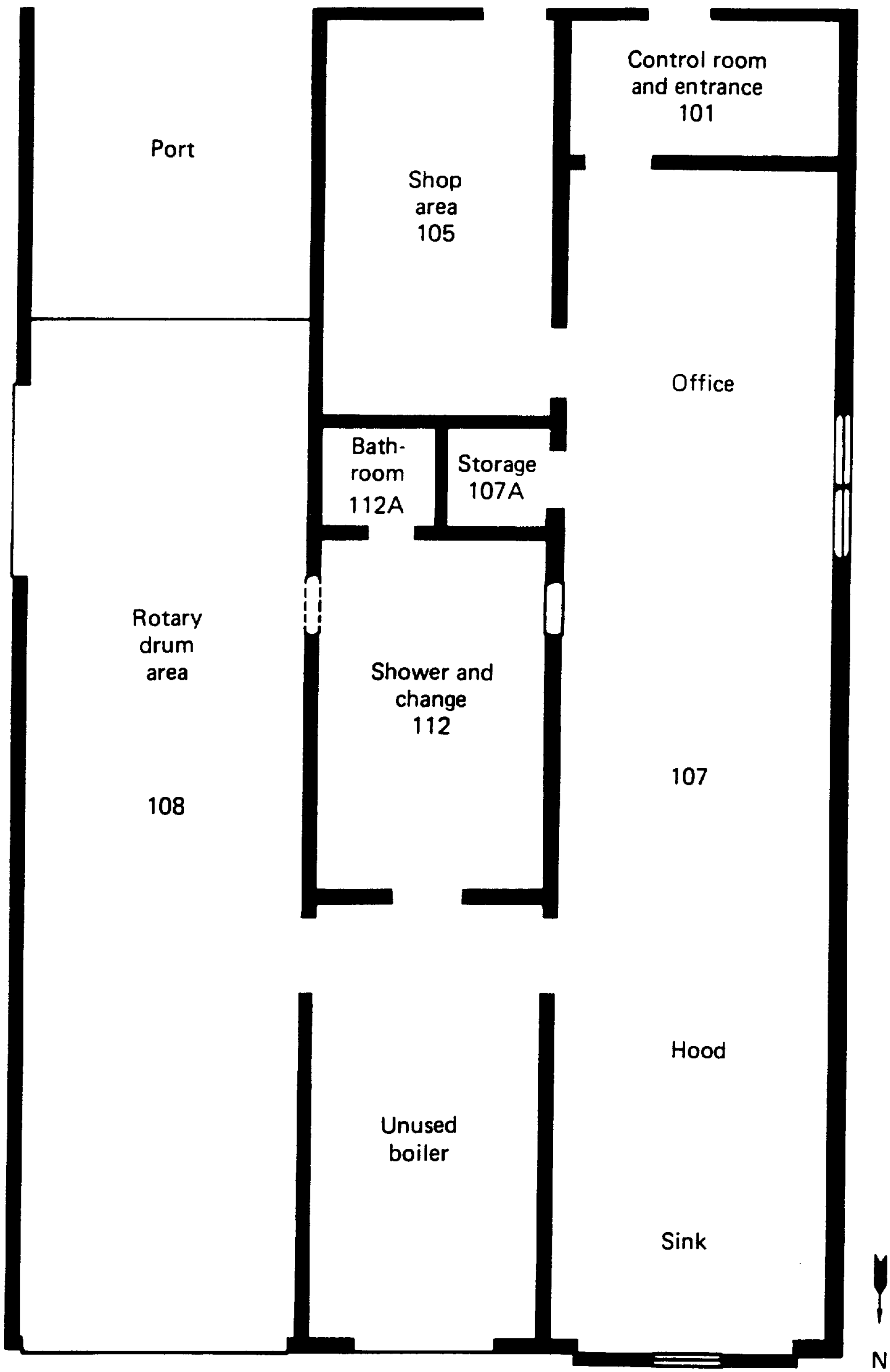


Fig. 2-2 Plan View of Bldg 514

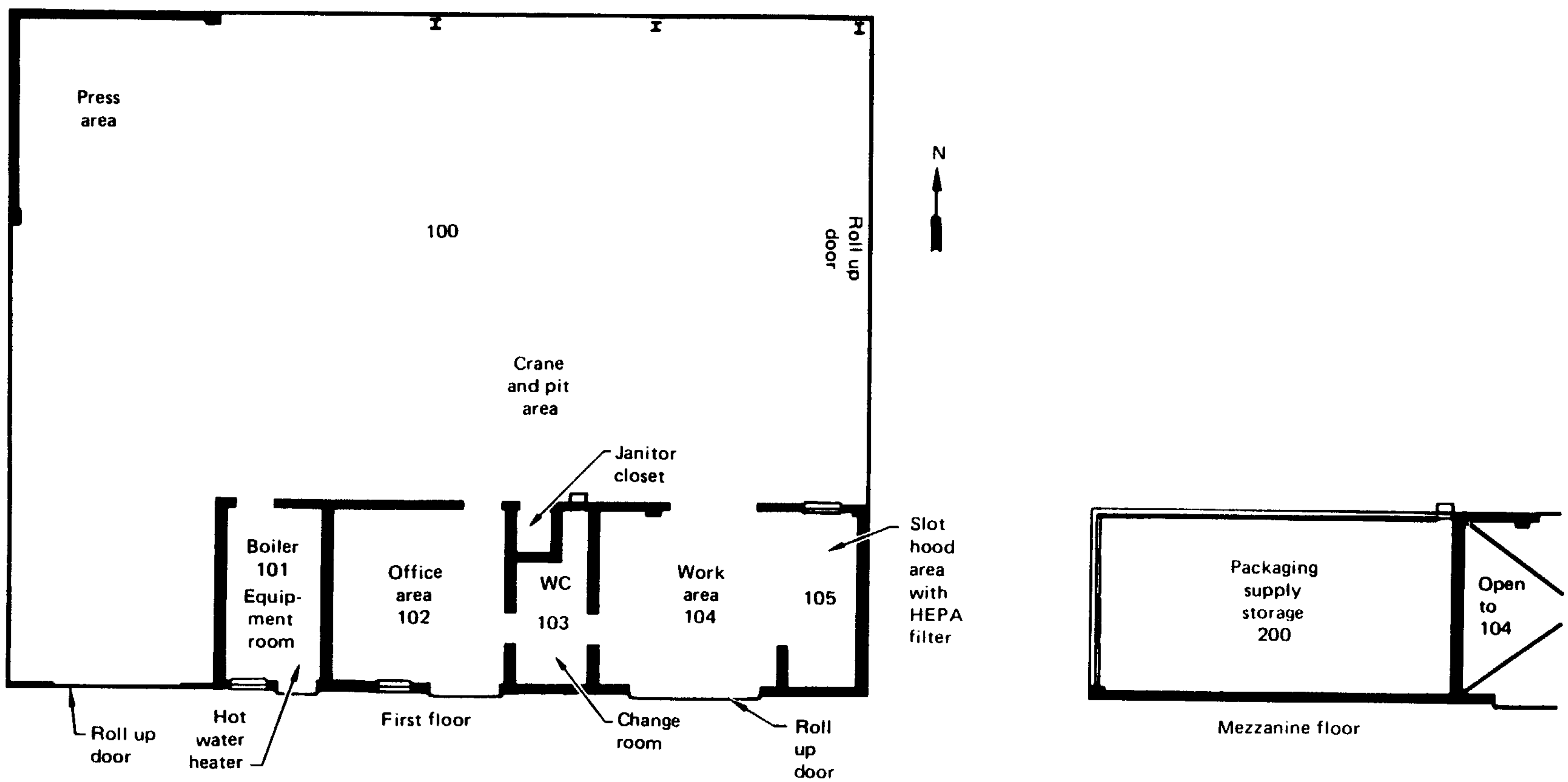


Fig. 2-3 Plan View of Bldg 612

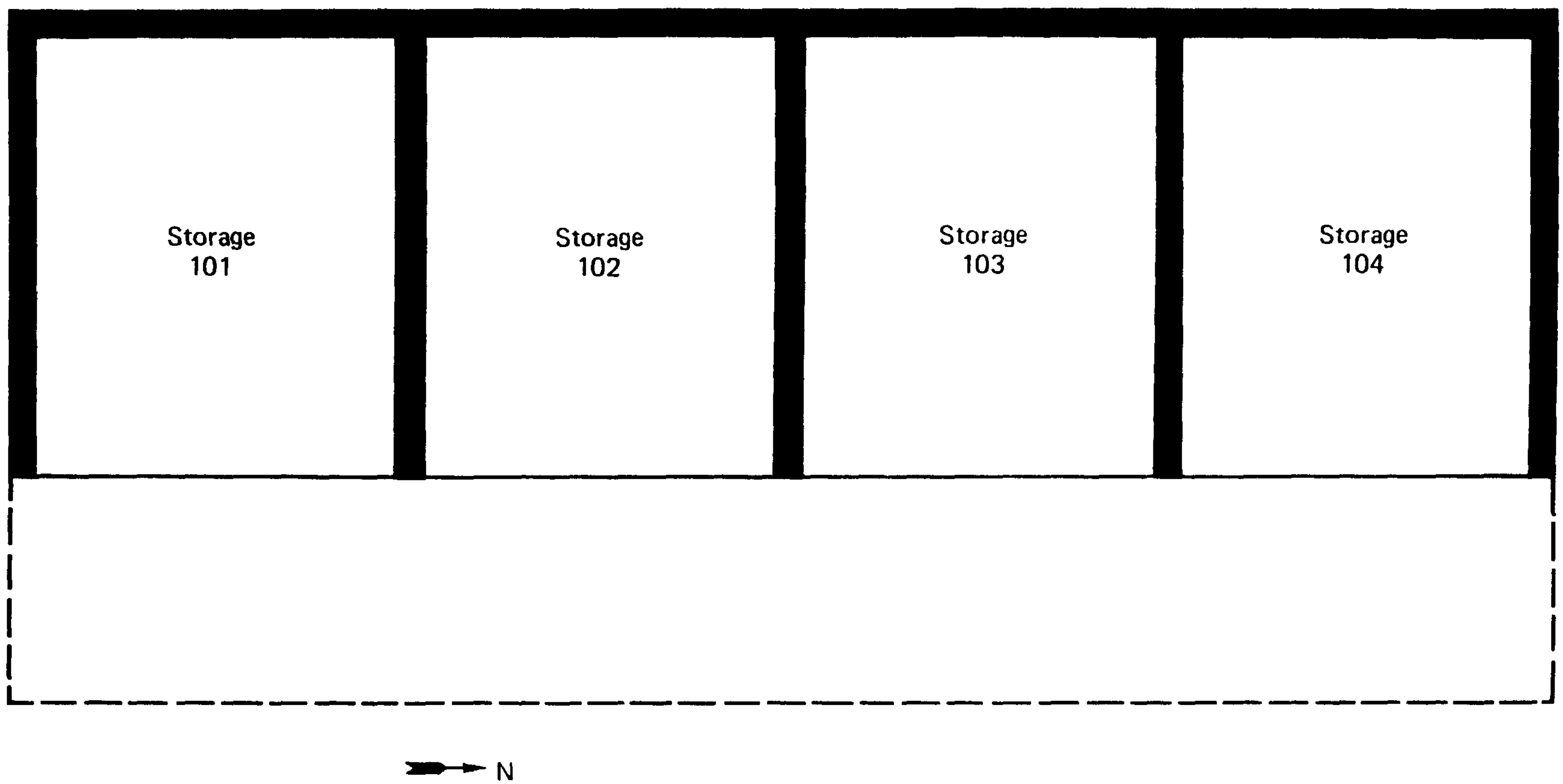


Fig. 2-4 Plan View of Bldg 614

SECTION 3 -- DESCRIPTION OF OPERATIONS

INTRODUCTION

This section briefly describes the handling of hazardous wastes including pickup, treatment, packaging, and disposal. (A more detailed description is contained in the LLL Waste Management Plan.)[3-1] Figure 3-1 charts the flow of LLL waste from the source to its ultimate disposal. Initially the waste is collected in either retention tanks, carboys, or drums (barrels). Low-level radioactive liquid wastes are collected in retention tanks while the somewhat higher level liquid wastes are collected in carboys. (Toxic chemicals and dissolved metals can be in either.) Solid hazardous wastes are collected in removable-top barrels while such items as cutting oils are collected in tight-head drums. The responsibile Hazards Control Technician for a particular facility identifies and quantifies the contents of the hazardous waste containers, tapes the containers together on pallets, and notifies the Waste Disposal Group that the material is ready to be picked up. The Hazards Control Technician also samples the contents of the retention tanks. The sample is then analyzed for pH, radioactivity, beryllium, copper, chrome, zinc, and nickel. The results are compared with pre-established LLL guidelines for the sanitary sewer, see Table 2-1. If the results are below these guidelines, the Hazards Control Technician dumps the contents of the tank into the sanitary sewer. If only the pH exceeds the sewer guidelines, the contents of the tank are neutralized and then dumped into the sanitary sewer. If the radioactivity, beryllium, or metal levels are too high, the Hazards Control Technician pumps the contents of the retention tank into a portable tank and notifies the Waste Disposal Group that the portable tank is ready to be picked up.

HAZARDOUS WASTE PICKUP, DELIVERY, AND TEMPORARY STORAGE AT WASTE DISPOSAL

Waste Disposal notifies Material Transportation when they want to have hazardous waste picked up. Material Transportation uses a forklift to haul the portable tanks to Building 514 and a truck to move the 5th wheel tankers to the Building 514 area. Material Transportation furnishes a flat bed truck, a forklift, and drivers to pick up the various pallets of barrels and carboys located throughout the LLL Site and haul them to the Building 612 area. A Waste Disposal employee rides in the cab of the truck to watch the load, make sure that the waste is properly packaged for pickup, and that the tags are filled out correctly. The forklift driver follows the truck and notifies the truck driver to stop if any containers are shifting about on the truck or if a spill occurs (a spill kit is on the truck). All of the solid waste is unloaded at Building 612 along with any carboys containing suspected carcinogens. The remaining carboys are sent to the Building 514 area.

The present practice at waste pickup points is to store radioactive, toxic, and corrosive materials near waste flammable liquids. Although no problems have resulted from this practice, the potential for contamination as a result of fire could be minimized if the flammable and corrosive materials were separated from each other and from the radioactive and toxic materials.

When the material reaches 612, the radioactive and non-radioactive materials are stored outside in adjacent rows. Some of the materials are identified by taped labels, some by shipping tags in protective plastic covers, and some by metal tags. Many of the labels had deteriorated and were in the process of falling off; especially those that were taped to plastic protective covers. Much of this material appeared to have been stored in the 612 area for an excessive period and the containers might be deteriorating.

Unlabeled or poorly labeled containers stored for long periods of time present a difficult fire fighting problem since the firemen won't know what materials are involved in the fire. It is recommended that the 612 yard be marked so that similar materials are stored together and separated from incompatible materials. It is also recommended that part of the yard be covered to keep the rain and sun off of the containers to reduce their deterioration.

Tables 3-1 and 3-2 list the types and quantities of hazardous materials at Bldgs 514 and 612 during the time this analysis was performed. It is recommended that this data be computerized so that it can be readily updated.

TRAINING

Many of the workers hired have had some training or experience that apply to waste disposal. Additional skills are obtained by personnel attending various classes sponsored by Hazards Control. These classes range from learning how to properly operate a forklift to handling radioactive materals. In addition, supervisors attend seminars on such subjects as waste disposal operations and handling of toxic materials. Much of the training is "on the job". All of this training and application should make for a well qualified staff. However, there is one major drawback. After obtaining a certain amount of training and skills, personnel are able to obtain higher paying jobs elsewhere. The overall result of this, in spite of good training, is an inadequately trained staff. Management needs to investigate means to decrease personnel turnover and improve morale. One possible solution is to upgrade the technician classifications so that higher salaries could be paid commensurate with similar jobs elsewhere.

BUILDING 514 OPERATIONS

The Building 514 area is designed primarily to treat large-volume, low-level liquid waste. This is accomplished by using several treatment tanks, plumbing, controls, and a diatomaceous-earth, rotary drum filter. The contents of the portable tanks are pumped into large stationary treatment tanks, see Fig 3-2. The lining of one treatment tank has deteriorated so badly that the tank is not used. Chemicals are added to precipitate and coagulate metal ions and radioactive materials. This material is then fed into the rotary drum that is coated with a 5-cm-thick layer of diatomaceous earth. The precipitate collects on the surface of the diatomaceous earth. As the drum rotates, a thin surface layer is constantly shaved off. These shavings (containing radioactive material and metals) are collected in a barrel. The barrel of solid waste is sealed and sent to Building 612 area where it waits for shipment to an authorized commercial burial site. The liquid is returned to a "clean tank" where it is again sampled for radioactivity and metals. If this liquid is below the prescribed LLL sewer guidelines, it is dumped into the sanitary sewer; otherwise it is retreated. If retreatment doesn't bring the levels down to the LLL sewer guidelines, the liquid is pumped into one of the 123 000 liter surge tanks. The material in the surge tanks is being stored until a new liquid waste treatment device such as a wiped-film evaporator or solar evaporator comes on line. Both of the surge tanks appear to be deteriorating. Recently cracks appeared in one tank and the plumbing for the other tank started leaking.

The rotary drum is being run almost daily. If it becomes disabled, there is no backup; therefore, the liquid waste will accumulate until the rotary drum is repaired (this should only take a day or so to replace items such as bearings). Although no accidents have occurred because of the inventory of liquid waste, the potential for such an accident could be lessened by preventing a large build up of hazardous liquid waste. The following recommendations are given to minimize the inventory of liquid waste.

- Consider providing backup equipment for the rotary drum.

- Investigate the increased use of ion exchange columns in facilities that are presently generating large amount of hazardous liquid wastes so that these liquids can be treated at the source and released to the sanitary sewer instead of being treated at Bldg 514.

- Investigate an education program for the experimenters generating the waste so that they will make better use of carboys and generate less low-level radioactive liquid waste that has to be treated at Building 514.

In addition to the liquid waste tank inventory, 2500 liters of radiation waste in carboys and 150,000 liters of radioactive cutting fluids and 189,000 liters of tritium contaminated water are presently being stored in the Building 514 area. Many of these containers have been standing around for a long time and are deteriorating. The contents of a deteriorated container can be pumped into a fresh container until a means of disposal is found. The radioactivity level in the carboys cannot be reduced by using the rotary drum because this would make the equipment too contaminated to treat the large-volume, low-level waste received from the various retention tanks.

At present, Building 514 personnel don't have the equipment to treat these materials. A wiped-film evaporator or solar evaporator has been proposed to evaporate the tritium. Neither of these has been built, although construction was started on the wiped-film evaporator. The radioactive wastes in the carboys could be evaporated in either the wiped-film evaporator or solar evaporator when they come on line.

Carboys, containing nonradioactive hazardous chemicals, are pumped into barrels. These barrels are then transported to Building 612 for disposal.

In addition to the above operations, Waste Disposal is responsible for the operation of the ion exchange plant in Building 321 and the retention tank in Building 131. In the past the contents of this tank have been hauled to a commercial chemical disposal site by a commercial waste handler. At the present time this tank will either be pumped out and processed at the Bldg 321 ion exchange plant or be pumped by a commercial waste handler and hauled to a commercial chemical disposal site.

Three types of waste are accumulating at Building 514 until means of handling them are instituted. These are:

- radioactive waste in carboys (These have higher concentrations of radioactivity than retention tanks).

- radioactive cutting fluids in barrels.

- large tanks of radioactive liquids that contain several curies of tritium.

Hazards Control Special Projects Division performed a study of Waste Disposal. This study highlighted many problem areas and included suggestions for alleviating these problems.[3-2]

BUILDING 612 OPERATIONS

Building 612 area is primarily the waste disposal facility for solid hazardous materials. Much of the radioactive solid waste (both TRU and non-TRU) is fed into a compacting machine that reduces the volume of the waste in the barrels, see Fig. 3-3. After the waste is compacted, the barrels are sealed. Objects that are either too large or that would damage the drum are either packaged in larger steel tanks (Bennett Buckets) or in specially constructed overpacks. The area for the compacting operation has shielding and HEPA filters; however it doesn't qualify as a Type III workplace as called for in Chapter RS701 of the Hazards Control Manual and in Ref 3-3. A proposal for such a workplace has been funded by LLL.

Barrels and overpacks containing TRU wastes are loaded into a specially designed DOT Type B shipping container (Super Tiger) that is transported to the DOE 20 year retrievable storage site at NTS. Barrels, Bennett Buckets, overpacks, and concrete blocks containing non-TRU radioactive waste are shipped by the selected vendor to an approved commercial burial site. The barrels, overpacks, and Bennett Buckets meet the requirements for DOT Type A shipping containers.

The nonradioactive chemical waste drums in the Bldg 612 areas are trucked by a commercial waste handler to an approved Class I landfill disposal site.

Solid and liquid wastes containing carcinogens but no radioactive materials except trace quantities of tritium (less than 1 μCi/g) are disposed of through the incinerator, see Fig. 3-4. A liquid injection system has been installed to inject the contents of the glass carboys directly into the incinerator. These glass carboys are then rinsed out and smashed in the compactor and disposed of with the radioactive waste.

Other nonradioactive hazardous liquid waste contained in carboys is sent to the Bldg 514 area where it is pumped into drums. These drums are then sent back to Building 612 for temporary storage. The solid chemical wastes are packaged in drums at Building 612 and temporarily stored. A commercial waste handler trucks the nonradioactive solid and liquid hazardous waste drums to a Class I landfill disposal site.

About 30 liters per year of over-aged ethers and other solvents that may have autoxidized to form shock sensitive peroxides are opened remotely outside of Building 612 and allowed to evaporate. Gaseous, non-radioactive waste bottles are collected at the Building 612 area and transported to Site 300 (see Fig. 3-4). These containers are blown up by explosives on one of the Site 300 firing tables.

Two kinds of waste are accumulating in the 612 area. These are:

- Polychlorinatedbiphenyls (PCBs) will start accumulating after March 1, 1981 because EPA restrictions prevent their being sent to any disposal site.

- Containers of unknown quantities of NaK, barium, lithium, and rubidium are being stored in Building 614 until some means is devised to dispose of them.

Table 3-1. Bldg 514 Area Waste Inventory (10-1-79)†

No.	Containers	Radioactive	Non Radioactive	Liters
131	Carboys*	X		2480
64	Carboys		X	1211
60	Lard cans**	X		454
20	Lard cans		X	151
14	Boxes		X	176
1	Portable tanks (machine coolant and oil)	X		7570
684	Drums (machine coolant & oil)	X		142392
96	Drums (taxi strip concentrates)	X		19985
162	Drums (unmarked, unknown)		X	16881
15	Drums (misc. concentrated sludge)	X		3123
5	Drums (acid waste)		X	1041
16	Drums (acid waste)	X		3331
3	Drums (base waste)		X	625
7	Drums (base waste)	X		1457
5	Drums (solvents)		X	1041
3	Drums (solvents)	X		625
2	Surge tanks	X		189250
10	Carboys (tritium liquid waste)	X		189
24	Lard cans (tritium liquid waste)	X		182
21	Drums (tritium liquid waste)	X		4372
			Total	396536

*Carboys contain 19 liters

**Lard cans usually contain 7.6 liters

†In some cases, approximate values are used.

Table 3-2. Bldg 612 Area Waste Inventory (10-1-79)*

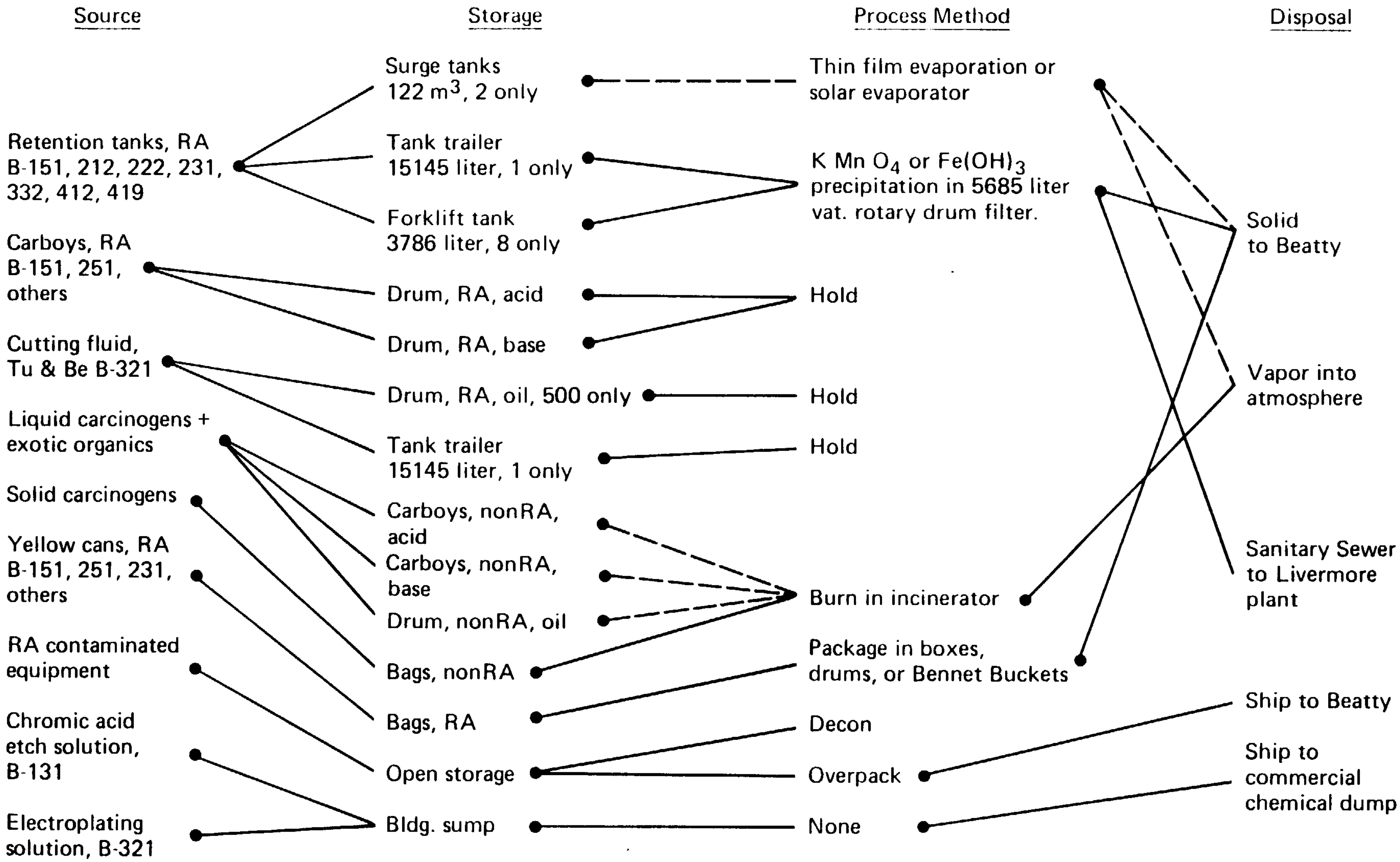
I. Waste To Be Processed
    A. Radioactive
        1. TRU
            a. 80 drums
        2. Non TRU
            a. 550 drums of dry waste
            b. 100 empty carboys
            c. 220 empty oil/coolant drums
            d. 140 empty chemical drums
            e. 15 drums of D38 scrap
            f. 65 15 m^3/min filters
            g. 65 yds of soil, rubbish, and debris from the taxi strip and salvage yard.

    B. Non-Radioactive
            a. 450 carboys of carcinogenic liquids
            b. 40 drums of liquid waste to repackage
            c. 152.4 m^3 of misc chemicals
            d. 100 gas cylinders
            e. 10 NaK containers
            f. 10.7 m^3 of misc pyrophorics

II. Waste To Be Shipped
    A. Radioactive
        1. TRU
            a. 9 drum of dry waste
            b. 3 steel overpacks
        2. Non-TRU
            a. 320 drums of dry waste
            b. 33 Bennett Buckets
            c. 3 overpacks
            d. 7 concrete blocks

    B. Non-Radioactive
            a. 48.2 m^3 of misc chemicals for Zero Waste
            b. 200 drums of liquid chemicals
            c. 7150 PCB capacitors
            d. 17 drums of Be waste

* In some cases, approximate values are used.



The solid lines indicate present flow paths. The dashed lines indicate paths that had previously been proposed but not implemented.

Fig. 3-1. LLL Waste Flow Chart

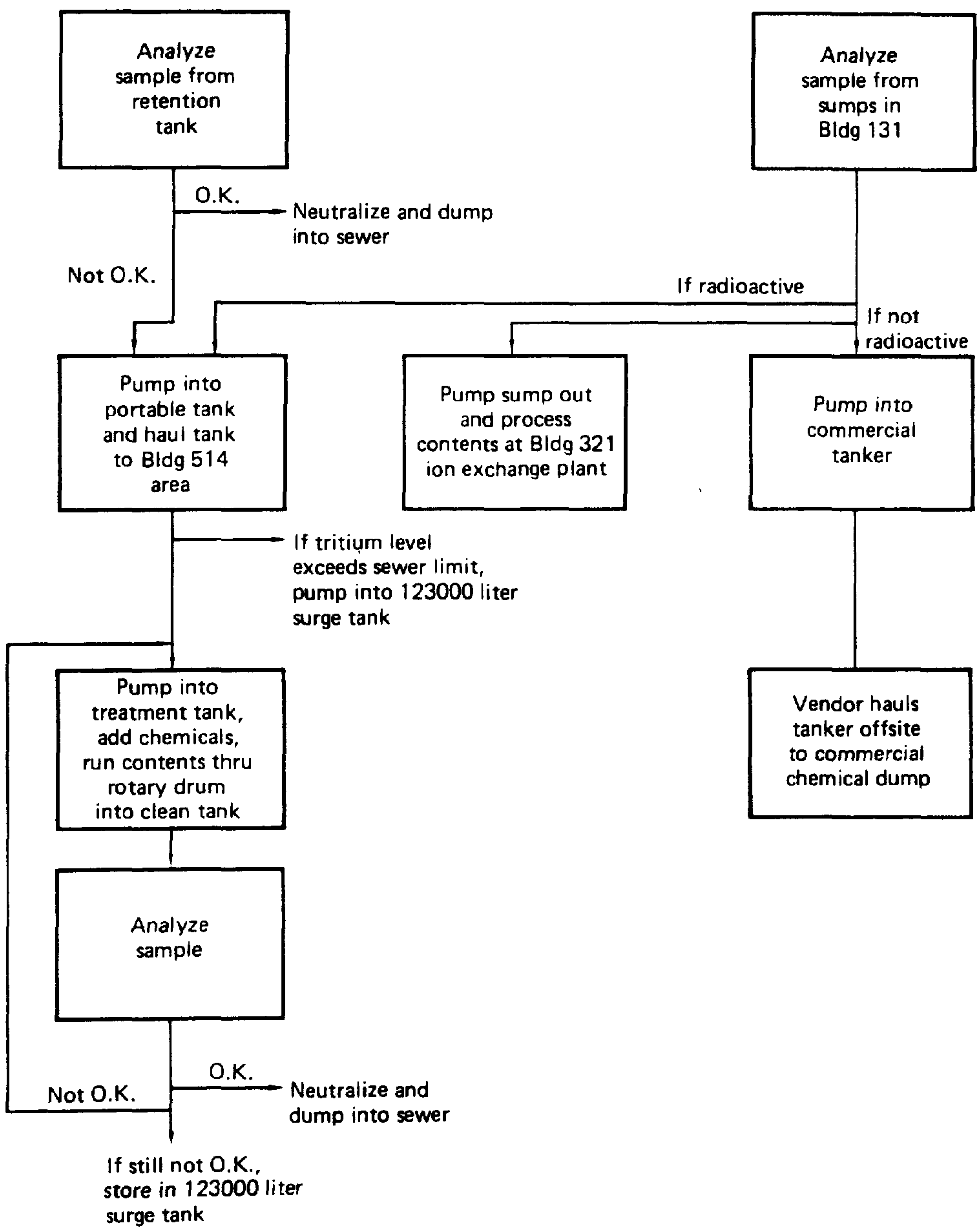
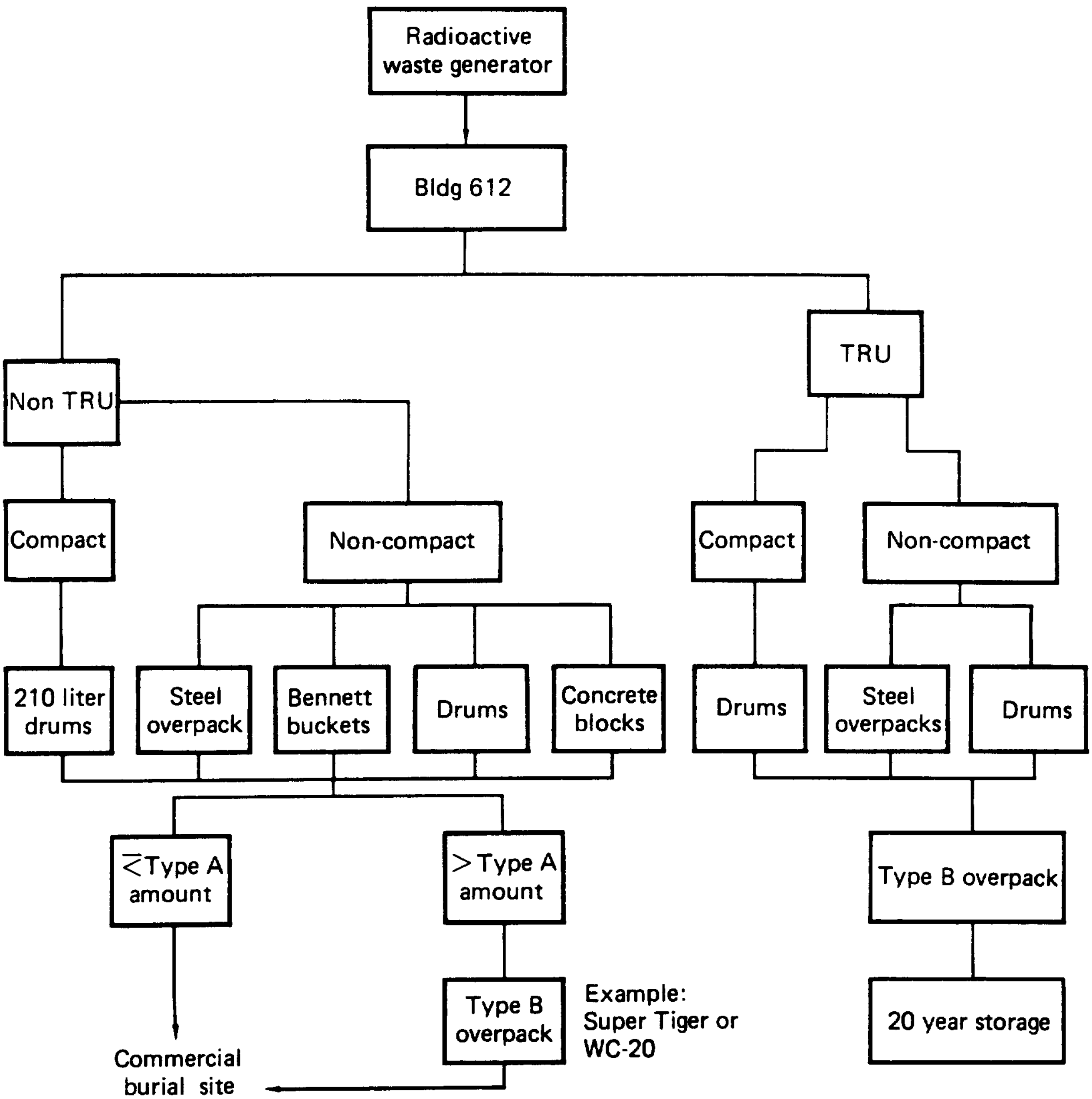


Fig. 3-2 Handling of Large-Volume, Hazardous-Liquid Waste



Example:
H_3
Transport group VII
Type A ≤ 1000 Ci
Type B > 1000 Ci and ≤ 50,000 Ci

Fig. 3-3 Handling of Radioactive Solid Waste at Bldg 612

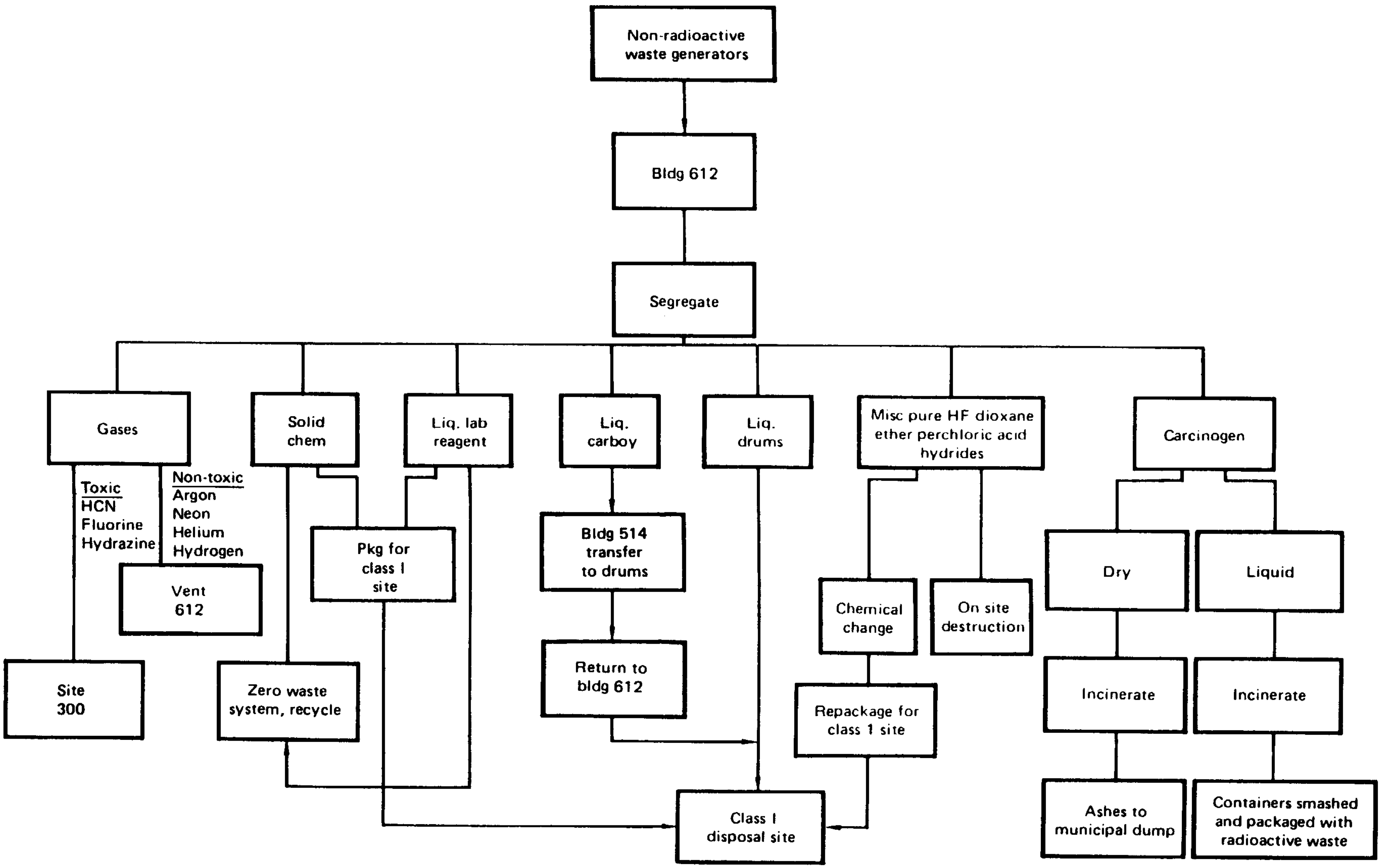


Fig. 3-4 Handling of Nonradioactive Chemical Waste at Bldg 612

REFERENCES

3-1 LLL Waste Management Plan

3-2 R.A. da Roza, Waste Disposal Study, Private Communication, Sept. 20, 1979.

3-3 B. N. Odell and A. J. Toy, TRU Waste Handling at Building 612, Private Communication, June 8, 1979.

SECTION 4 -- RISK ANALYSIS

INTRODUCTION

As shown in the previous section, the Waste Management facilities, by necessity, accumulate quantities of reactive, toxic, and radioactive waste. Although the operation of these facilities at LLL has not led to any significant releases to the environment, the potential exists for such releases. Two lost time injuries have occurred during operation of the facilities; a rate of 1 per 100,000 man-hours. This rate is at the average for LLL and below the U.S. industrial rate. However, this systematic review has demonstrated that the risk may be further reduced.

A review of the hazardous materials handled in these facilities showed that there were insufficient quantities of radioactive materials to qualify them as nuclear facilities per DOEM 0531. However, this review is required by DOE Order 5481.1.

This section discusses the various hazards and mitigating features and the potential accidents caused by acts of nature and human error.

Risks of these hazards vary from low to moderate depending on the probability of an accident occurring and its consequences. The moderate risks are from those hazards that involve TRU materials and toxic chemicals at 612 and carboys and tanks containing radioactivity at 514.

HAZARDS AND MITIGATING FEATURES

This systematic safety analysis was performed using document review and on-site inspections, as well as input from the client and from the various safety disciplines. In addition to a survey of materials and equipment, this review also examined the management of these facilities. Current safety and accident prevention studies have shown that proper management is as important to risk reduction as proper equipment. This review points out several areas for additional management attention. All of the hazards (energy sources) that are deemed appropriate for each facility and each operation are listed in Table 4-1. The mitigation features (barriers) that will reduce these hazards to acceptable levels are listed in Table 4-2. Appendix 4A identifies which barriers are adequate as well as those that are less than adequate. The footnote in Appendix 4A summarizes the less than adequate barriers that are common for several energy sources. These primarily involve supervision and the enforcement of administrative controls and procedures. This in turn caused an excessive amount of waste to accumulate over several years as well as the degradation of equipment. Recently, there has been a turn around. Supervision has changed and some improvements have already been made or are in process. Many of the additional barriers that are needed are in the process of being provided. The new supervisor has the support of management and is initiating requests for equipment, upgrading procedures, building personnel morale, shipping waste, and cleaning up the temporary storage facilities. Some of these improvements require considerable engineering and/or large expenditures which will require additional time before these improvements can be accomplished. The status of the findings from this safety analysis are summarized in Section 5.

ACTS OF NATURE

These facilities will withstand most accidents caused by acts of natural phenomena (wind, missile, lightning, flood, and earthquake) since they were designed to meet or exceed the requirements of the Uniform Building Code. This is an appropriate design code since these are not nuclear facilities.

Wind

A study of tornadoes[4-1] concluded that tornadoes do not pose a significant threat of structural damage in the central California area. High winds are rare. The structures are designed to withstand 38 m/s winds by the UBC. These winds are calculated to occur with a probability of 0.001 per year.[4-1]

Missile

High winds at LLL are not strong enough to produce missiles that threaten these buildings. Large aircraft as missiles were also considered but rejected as credible due to the low probability of impact on buildings this size.[4-2]

Lightning

Studies of the thunderstorm activities in the Livermore Valley indicate that thunderstorms occur less than five days per year, are not intense, and do not last more than one-half day per storm.[4-3] No modifications are required for lightning protection at Building 612 or 514.

Flood

An analysis performed at LLL and by the Department of Housing and Urban Development indicate that the LLL site would be unaffected by a postulated 100-yr flood[4-1, 4-4].

Earthquake

As a result of a previous commitment, structural analyses were performed on the two large storage tanks in the Building 514 area and on Building 612. The earlier analysis of the storage tanks showed that they would withstand a ground acceleration of 0.5G.[4-5] However, a recent on-site inspection revealed new cracks in the outer shell of one of these tanks. Failure of these tanks could release radioactive liquids to the sanitary sewer in excess of LLL guidelines. Immediate steps were taken to repair the tank. It is recommeded that Building 514 and its associated facilities be evaluated to the present UBC earthquake resistance criteria since it handles significant quantities of radioactive waste. It is further recommended that any discrepancies revealed in this evaluation be remedied. The analysis of Building 612 indicated that the factors of safety for the stress collectors in the roof are less than one at the UBC levels.[4-6, 4-7] The roof should be upgraded to withstand the UBC earthquake since some radioactive waste might be released given that an earthquake could collapse the roof which, in turn, might rupture a waste container in the building, resulting in local spread of radioactivity.

HUMAN ERROR

The most common hazards that may be encountered during operation of these facilities are those considered as industrial type accidents. These occur primarily because this is a "hands on" type of operation. In addition, there exists a possibility for the exposure of personnel to radioactivity, carcinogens, toxic chemicals as well as explosions and/or fires. Of the possible acccidents, the one having the severest off-site consequences is a fire that releases radioactivity.

Fire

Buildings 514, 612, and 614 are concrete structures; only Building 612 is sprinkled because combustible wastes are packaged there. Portable fire extinguishers are appropriately located in Buildings 514 and 612 and fire hydrants are readily accessible to these facilities as well as to the yards that surround them. The response time for the Fire Department upon receiving an alarm is two minutes.

The potential fire problems in the 612 area are the chemicals, solvents, and radioactive materials that are presently located in close proximity to each other in addition to more common fire hazards such as over heated equipment.

Although the fire protection in 612 meets LLL standards, the following steps could be undertaken to enhance the fire safety of the 612 area:

- Remove all bulk chemicals and solvents from inside Building 612. These could be segregated and appropriately stored in the new storage facilities that are planned for construction in 1980.
- Temporarily store all potentially shock sensitive peroxides inside Bldg 614.
- Divide up the 612 yard into small areas so that incompatible materials can be separated from each other. This can be done by painting stripes on the asphalt yard and identifying these small areas as to the kinds of materials that can be stored in them.

Maximum Credible Release

The required practice in 612 is to seal each drum as it is filled, thus the maximum credible release is assumed to result from a fire occurring in or adjacent to a single waste drum containing plutonium. Experiments have shown that only 0.05% of the plutonium involved in a fire became airborne, see Appendix 4B. Calculation indicate that the maximum amount of plutonium contained in one drum must not exceed 30 g if the possible fence-line dose is to remain less than 500 mrem specified by DOEM 0524. Since the mass limit for one drum was reduced to 15 g for shipping purposes, the off-site dose would be 250 mrem (see Appendix 4C). The maximum on-site dose from a fire in one drum containing 15 g of ^{239}Pu is 5 rem.

Table 4-1. List of Energy Sources (Hazards)

Electrical

High Lines
Transformers
Wiring
Underground Wiring
Cable Runs
Service Outlets and Fittings
Pumps
Motors
Heaters
Power Tools
Small Equipment

Nuclear

Criticality
Radiation

Thermal Radiation

Furnaces
Boilers
Steam Lines
Solar
Hot plate
Welding, Burning, Soldering Equip
Polymers & Catalysts
Electric Wiring and Equipment

Kinetic-Rotational

Centrifuges
Motors
Pumps
Gears
Shop Equipment (Grinders, Saws, Brushes, etc.)
Stirrers in Tanks

Corrosive

Acids
Caustics
Oxidizers
Reducers
"Natural" Chemicals (Soil, Air, Water)
Decon Solutions

Explosive Pyrophoric

Metal Powders
Dusts
Hydrogen (Incl. Battery Banks and Water Decomp.)
Gases-Other
Nitrates + Organics
Electric Squibbs
Peroxides-Superoxides
Aging Chemicals (Ether)
Perchlorates + Organics
Na, K, NaK
Acids + Alcohols
HE

Flammable Materials

Packing Materials
Rags
Gasoline (Storage and in Vehicles)
Lube Oil
Coolant Oil
Paint Solvent
Buildings and Contents
Grease
Hydrogen (Incl. Battery Banks)
Gases - Other
Spray Paint
Solvent Vats
NaK
Ethers
Acetone
HE
Propellants

Toxic/Pathogenic

Acetone
Fluorides
Carbon Monoxide
Lead
Ammonia and Compounds
Asbestos
Trichlorethylene
Polymers & Catalysts
Dusts and Particulates
Pesticides-Herbicides-Insecticides
Bacteria
Beryllium and Compounds
Chlorine and Compounds
Decon Solutions
Sandblast Compounds
Metal Plating Chemicals

Table 4-1. List of Energy Sources (Hazards) - continued

Chemical Carcinogens

2-Acetylamino Fluorene
Benz(a)anthrancene
Benzene
Benzo(a)pyrene
Benzidine
Daizomethane
Dibenz(a,H)anthrancene
9,10-Dimethyl-1,2-Benzanthrancene
1-Ethylnitrosourea
Hydrazine Sulfate
Methanesulfonic Acid, Ethyl Ester, EMS
Methylazoxy Methanol Acetate
3-Methyl Cholanthrene
Methyl Methane Sulfonate (MMS)
N-Methyl-N-Nitro-N-Nitrosoguanidine
Mitomycin C
1-Naphthylamine
2-Naphthylamine
N-Nithrosodiethylamine
N-Nithrosodimethlamine
Triethylenethiophosphoramide

Presumptive Chemical Carcinogens

2-Aminoanthracene
Anthracene
Azaserine
Benzo(e)pyrene
N-Butyl-N-(4-Hydroxybutyl) Nitrosoamine (BBN)
Chrysene
Cyclophosphamide
2,7 Dinitrofluorene
Epichlorohydrin
Ethionine
Ethylene dibromide
8-Hydroxyquinoline
ICR 170
ICR 191
4-Methoxy-2-naphthylamine
N-Nitrosodiphenylamine
Phenanthrene
Picene
Quinoline, 4-Nitro, 1-Oxide
Thiourea

Mass, Gravity, Height

Human Effort
Stairs
Lifts
Cranes
Bucket and Ladder
Trucks
Slings
Hoists
Scaffolds and Ladders
Pits
Vessels

Pressure-Volume/K-Constant-Distance

Boilers
Gas Bottles
Pressure Vessels
Coiled Springs
Compressed Air
Hydraulic Systems

Kinetic-Linear

Trucks
Fork Lifts
Carts
Dollies
Surfaces
Presses
Crane Loads in Motion
Gun Powder Assisted Driving Tools
Power Assisted Driving Tools
Conveyer Lines

Acoustical Radiation

Equipment Noise
Ultrasonic Cleaners

Table 4-2. List of Barriers (Mitigating Features)

Barriers

1. Adequate Management
2. Administrative Controls and Procedures
3. Supervision
4. Training
5. Audits
6. Quality Assurance
7. Monitoring (Health and Safety Techs
8. Professional Advice
9. Inspection and Maintenance
10. Inventory and Mass Control
11. Adequate Time for Job
12. Minimum Storage to Disposal Time
13. Spill Team
14. Instrument Monitoring
15. Instrument Verification
16. Labeling (quantities and type of materials, chemicals, switches, etc)
17. DOE Safety Codes
18. Proper Design of Facilities
19. Remote Operation
20. Constructed to Codes (electric, plumbing, UBC, etc)
21. Material segregation
22. Proper Equipment (tools, tanks, barrels, forklifts)
23. Protective Devices (guards, radiation shields, blast shields, interlocks, lock and tag, limit switches, shorting bars, fences)
24. Warning Devices (signs, bells, horns, lights)
25. Ventilation, Hoods, Filters
26. Syphoning and Pumping
27. Hand and Foot Counter
28. Air Sampler
29. Nonsparking tools and Equipment
30. Fire Department, Sprinklers, Water Availability, Fire Extinguishers
31. Protective Clothing (hard hats, safety shoes and glasses, booties and gloves, flack vests, ear plugs)
32. Respirators
33. Local Radiation Alarms
34. Remote Alarms (at Fire or Police Stations)
35. Security

REFERENCES

4-1 B. N. Odell, Supporting Documents for LLL Safety Analysis Reports, Lawrence Livermore Laboratory, Livermore, Ca, UCRL 51801, 1975.

4-2 D. M. Boorirn, An Aircraft Accident Probability Distribution Function Trans. Amer. Nucl. Soc. 18; 225-226, June 1974.

4-3 E. D. Sunde, Earth Conduction Effects in Transmission Systems, Van Nostrand, New York, 1949.

4-4 J. T. Limerinos et al, "Flood Prone Areas in the San Francisco Bay Region", U.S. Department of Housing and Urban Development, Interpretive Report 4 (1973).

4-5 C. Y. King, "Bldg. 514, Investigation of the Seismic Resistance of 34 000 Gallon Liquid-Waste Storage Tanks," Private Communications, April 30, 1979.

4-6 B. Murray and D. Coats, Seismic, Tornado, and Extreme Wind Analysis of Building 612, Private Communication, SM 79-293, October 15, 1979.

4-7 D. Coats and B. Murray, Review of Building 612 for UBC Seismic Free Levels, Private Communication, SM 79-343, November 5, 1979.

SECTION 5 -- SUMMARY OF FINDINGS AND RECOMMENDATIONS

This section summarizes the findings of the safety analysis for the Waste Management facilities. These findings have been discussed with the Waste Management group leader. Where corrective action has been instituted or planned, that action is summarized. Where no action is planned, the reason for no action or a recommended action is given. It is the responsibility of the authors of this safety analysis to see that responsible LLL management is aware of the findings of this analysis and all actions (or inactions) taken as a result.

FINDINGS

- Two surge tanks are storing liquids containing tritium and other radioactive materials that can't be treated using present methods. These tanks are deteriorating. Numerous drums are being stored that contain radioactive cutting fluids. A wiped film evaporator is being constructed to treat these wastes.
- Carboys containing radioactive liquids are accumulating. Waste Management personnel will start a solidification effort in June, 1980.
- Containers of unknown quantities of NaK, barium, lithium, and rubidium are being stored. Disposal efforts have begun.
- Materials containing PCB's will start accumulating in 1981 because EPA restrictions prevent their being sent to any disposal site. These will be stored until approved disposal exists. No new PCB containing equipment is being purchased at LLL.

- Lining in treatment tanks at Bldg 514 are deteriorating. A replacement program has begun.
- Unnecessary amounts of hazardous liquid waste are constantly being treated at Waste Disposal. Recommendation: Consider increased use of ion exchange at point of generation. Further educate generators of waste.
- Building 514 and its associated facilities may not meet present UBC earthquake resistance criteria. Recommendation: Have qualified engineers analyse the problem. Implement suggested modifications.
- Compactor operation for TRU waste is not being performed in a Type III workplace. Money has been allocated to upgrade the facility and plans are being drawn.
- There is no emergency power for waste press exhaust ventilation at Bldg 612. Recommendation: Install an emergency generator.
- Building 612 does not meet 1979 UBC earthquake resistance criteria. Recommendation: Perform suggested modifications to upgrade the roof to meet this criteria.
- Interlocks on shielding doors of waste press did not operate properly. Doors have been reworked to make interlocks work.
- Containers of incompatible materials are being stored together at point of pickup. Some areas have been rearranged. The Health Physics Group has been asked to examine the remaining areas and recommend necessary changes.
- A potential exists for fire, explosions, and spills. The probability of these accidents will be minimized by training, operating procedures, and by providing segregated covered storage. This construction is planned for 1981.
- Containers are standing around and deteriorating. The new wiped film evaporator will reduce the backlog of untreated waste.

- There is no backup equipment for the rotary drum. Management has decided that waste will be stored until the equipment is fixed. This should take only a day or so.
- Staff training and morale, as well as management support, could be improved. LLL Management is aware of this problem. A new Group Leader now heads the Waste Management Program. He is giving the problem high priority.
- Excessive time involved (two months) with selecting a vendor to ship non-TRU radioactive waste leads to large inventories. The shipping practice has been changed. 10-day shipment of waste will now be carried by LLL vehicles to NTS for burial.
- Excessive hazardous waste is being shipped. Recommendation: Institute a program to educate operators on minimizing their waste volumes.
- There is no easily retrievable data on type, amount, and location of the hazardous waste in Waste Disposal. Recommendation: Consider the use of some type of inventory identification system.
- There is a potential head knocker problem to the operator of the diatomaceous-earth, rotary drum filter in Bldg 514. Recommendation: Relocate or pad piping, or provide hard-hat protection.
- Diatomaceous earth dust is produced in air when emptying bags of this material in the rotary drum area in Bldg 514. Recommendation: Require the use of suitable respiratory protection.

RECOMMENDATIONS TO FURTHER MINIMIZE RISKS

- Have Hazards Control Special Projects Division and outside consultants continue to study the technical problems associated with the disposal of hazardous waste and then make recommendations for the solutions of these problems.
- Construct a solar evaporator to handle most of the liquid waste including the radioactive liquids in carboys as well as the liquid containing tritium that is presently stored in the two large surge tanks.
- Implement an inspection and maintenance program for all essential equipment such as tanks and their associated plumbing.
- Remove bulk chemicals and solvents from inside Bldg 612.
- Store potentially shock sensitive materials inside Bldg 614.
- Mark the 612 temporary storage area so it is obvious that similar materials are stored together and not stored with incompatible materials. This would let Emergency Response Personnel know the possible types of materials involved in a fire and/or explosion.
- Install an automatic shut-off for the rotary drum filter if cooling water for the bearings is lost.

Appendix 4A

Summary of Energy Sources, Barriers, and Comments

Table 4A-1. Summary of Energy Sources, Barriers, and Comments

Energy Involved	Existing Barriers	Additional barriers needed	Comments
A. Electrical	1,2,3,4,5,6,8,9,11, 15,16,17,20,22,23,24		
B. Nuclear criticality	1,2,3,4,7,8,10,11, 14,15,16,17,21	5	Not presently on audit list
C. mgh	1,2,3,4,8,9,11,17, 18,19,20,22,23,24,31		
D. pv-kd	1,2,3,4,8,9,11,17, 18,19,20,22,23,24,31		
E. KE-linear	1,2,3,4,8,9,11,17, 18,19,20,23,24,31	22	Need modified forklift to move drums in and out of Super-tiger †
F. KE-rotational	1,2,3,4,8,9,11,16,17, 18,19,20,22,23,24,31		
G. Corrosive	2,8,11,13,19,20,22, 23,25,26,30,31,32	1,3,4,5,6,7,9,10, 12,16,17,18,21,24	* **
H. Explosive-pyrophoric	2,8,11,13,19,20, 22,23,29,30,31	1,3,4,5,6,7,9,10,12, 16,17,18,21,24,35	* **
I. Toxic-Pathogenic-Carcinogenic	2,8,11,13,19,20,22 23,25,26,30,31,32	1,3,4,5,6,7,9,10,12, 16,17,18,21,24,35	* **

† This has been accomplished.

Table 4A-1. Summary of Energy Sources, Barriers, and Comments (continued)

Energy Involved	Existing Barriers	Additional barriers needed	Comments
J. Flammable	2,8,11,13,20,22, 23,26,29,30,31,34	1,3,4,5,6,7,9,10,12, 16,17,18,21,24	* **
K. Thermal	1,2,3,4,8,9,11,16,17, 18,20,22,23,24,30,34		
L. α, β, γ radiation	8,10,11,13,14,15, 22,25,26,30,31,32	1,2,3,4,5,6,7,9,12,16,17, 18,20,21,23,24,27,28,35	Need a good contamination control program at Bldg 514 and 612. TRU waste should be handled in a secured Type III workplace. Existing Bldg. 612 does not meet these requirements; radioactive materials not segregated from incompatible materials at point of pickup. Inadequate interlocks on press at Bldg 612. * **
M. Acoustical radiation	1,2,3,4,8,9,11, 17,20,22,31		

* Lack of proper
 2. Administrative controls and procedures
 3. Supervision
 4. Training
 5. Audits
 6. Quality assurance
 7. Monitoring
 9. Inspection and maintenance
 10. Inventory and mass control
 12. Minimum storage to disposal time
 21. Material segregation

** Labels not protected from weather, illegible, and can fall off

Appendix 4B

Setting An Acceptable Maximum Inventory of TRU Material
in the Hi Bay of Building 612

383

29189

March 8, 1979

TO: E. G. Snyder

FROM: C. L. Graham

SUBJECT: Setting an Acceptable Maximum Inventory of TRU Material in the Hi Bay of Building 612

REFERENCE: J. Mishima and L. C. Schwendiman, Fractional Airborne Release of Uranium (Representing Plutonium) During the Burning of Contaminated Wastes, BNWL-1730, Battelle-Northwest, Richland, Washington, April 1973

Maximum Inventory of Radioactivity in Building 612

To derive the maximum inventory of TRU materials permissible in Building 612, the off-site (fence-line) and on-site consequences of such a release to the atmosphere have been calculated. These consequences can be compared with appropriate standards (DOE, EPA) to calculate a source term from which a building inventory can be inferred. Three consequences were calculated: (1) lung dose to a person at the nearest site boundary (290 m) in the downwind centerline of the "cloud" during it's passage (2) lung dose to a person on-site who remains in the "cloud" during its passage and (3) surface (soil) contamination levels at the site boundary from deposition of particulate material in the passing cloud.

Maximum Credible Personnel Exposures

The maximum credible release is assumed to result from a fire in a waste drum containing TRU material. Since all drums are sealed after filling, it is not considered credible that a fire could start in more than one drum. If a major fire occurred in the building, it is not considered credible that more than one drum would have a significant release. A major fire is highly unlikely to generate enough heat to jeopardize the integrity of sealed drums because of the high ceiling and low fire loading of the hi-bay.

The TRU material stored in Building 612 is assumed to be an oxide and made up of respirable size particles. The fraction of TRU material which becomes airborne is assumed to be 5×10^{-4} as suggested by the reference. These assumptions are conservative with respect to the projected doses and ground deposition. Thus, for a 10-minute release period and applying the diffusion value that is exceeded only 5% of the time, $X/Q = 4.8 \times 10^{-3}$ s/m^3, the concentration of TRU material at the LLL site boundary during cloud passage is

$$\frac{(A\ Ci)\ (5 \times 10^{-4})\ (10^{6}\ \mu Ci/Ci)\ (4.8 \times 10^{-3})}{(10\ min)\ (60\ s/min)} \text{ in } \mu Ci/m^3$$

where A is the maximum activity of TRU allowed in a single container.

The maximum air concentration of insoluble TRU material that could be inhaled by a person breathing this fence-line cloud without exceeding the fence-line dose of 500 mrem (per DOEM Chapter 0524) is then determined.

Using the standard-man parameters of the ICRP:

- breathing rate of $20 m^3$/day
- mass of critical organ (pulmonary lungs of 600 g)
- fraction retained (long-term) in lungs of 0.15
- effective energy per disintegration of 52 MeV (typical energy of TRU material including the Q factor)
- biological half life of 500 days,

the fence-line concentation which would lead to a 500 mrem dose is $7.5 \times 10^{-3}\ \mu Ci/m^3$. Therefore,

$$A = \frac{(600s)\ (7.5 \times 10^{-3}\ \mu Ci/m^3)}{(5 \times 10^{-4})\ (10^{6}\ \mu Ci/Ci)(4.8 \times 10^{-3}\ s/m^3)} = 1.9\ Ci$$

The maximum air concentration of TRU material that could be inhaled by a person who is on-site and 50 meters from Building 612 is assumed to be twenty times that of the fence line concentration. It is not credible that a person would be exposed at closer distances without wearing respiratory protection because he would be warned to leave by the emergency response team.

Therefore, the maximum activity of TRU material in a single container for an on-site exposure resulting in a dose of 15 rem (per DOEM 0524) is 2.9 Ci.

Deposition of Activity in Soil @ Site Boundary

Using an approach similar to the method shown above for the atmospheric release, the surface soil concentration of TRU material can be calculated and compared to the proposed EPA standard of $0.2\ \mu Ci/m^2$ for transuranics in soil. Multiplying X/Q ($4.8 \times 10^{-3}\ s/m^3$) and release term (maximum inventory times fractional release) by the deposition velocity (0.01 m/s from the Reactor Safety Study, WASH-1400) the surface concentration is obtained. Comparing that value with the proposed EPA standard provides an estimate of the maximum single drum inventory. Hence,

$$(A)(5 \times 10^{-4})(10^{6}\ \mu Ci/Ci)(4.8 \times 10^{-3}\ x/m^3)(10^{-2}\ m/s) = 0.2\ \mu Ci/m^2$$

and

$$A = \frac{0.2}{(4.8 \times 10^{-3})\ (5)}\ Ci = 8.3\ Ci$$

The most restrictive case is that of personnel exposure at the fence line. Therefore, the maximum inventory of TRU material in any single waste drum in the hi-bay should not exceed 2 Ci.

If you have any questions regarding these calculations, please call me.

C L Graham

C. L. Graham
Health Physics Group
Hazards Control

CLG:sc

cc: T. J. Powell
D. S. Myers
C. M. Mickel
M. S. Singh

Appendix 4C

Change in the Acceptable Inventory of TRU Material in the Hi Bay of Bldg. 612.

25138

December 7, 1979

TO: R. S. Roberts

FROM: T. Straume

SUBJECT: Change in the Acceptable Maximum Inventory of TRU Material in the High Bay of Bldg. 612 (Revised)

The acceptable TRU inventory limits set forth by C. L. Graham on March 8, 1979,[1] have been changed to reflect recent ICRP[2] recommendations regarding the critical organ mass. In the past only the pulmonary region of the respiratory tract has been used in lung dose calculations from inhaled alpha emitters. This has been changed to include the trachea, bronchi, and pulmonary lymph nodes, totaling 1000 g. Performing C. L. Graham's calculations, using a 1000 g organ mass, the following is obtained:

1. Maximum Credible Personnel Exposure

   a. 500 mrem total dose at fence line could result from 3.2 Ci of ^{239}Pu.

   b. On site doses (at 50 m from Bldg. 612) of 15 rem could result from 4.8 Ci of ^{239}Pu.

2. Deposition of Activity in Soil at Site Boundary

   Unchanged

The maximum TRU inventory in any single waste drum in the high bay (Bldg. 612) should not exceed 3 Ci. For a nominal plutonium mixture (weapons grade) this is equal to about 30 g (assuming a somewhat conservative number of 0.1 alpha curies per gram). ^{241}Pu can be neglected for purposes of inhalation hazards evaluation due to its low energy beta decay but must be included for shipping purposes due to criticality considerations. Since the shipper is exempt from fissile shipment requirements as long as the fissile material is equal to or less than 15 g/package,[3] the quantity of Pu material per drum should be limited to 15 g.

Since the maximum activity limit per drum in the Bldg. 612 high bay is 3 Ci for TRU materials, masses of 15 g (the mass limit for Pu) may not be permitted for other TRU materials depending upon their specific activity; e.g., ^{244}Cm has specific activity of 83 Ci/g and would be restricted to $\leqslant$36 mg per drum.

T. Straume

T. Straume
Health Physics Group

TS:gw

References

1. Memo from C. L. Graham to T. Snyder dated March 8, 1979, subject: "Setting an Acceptable Maximum Inventory of TRU Material in the High Bay of Building 612."

2. ICRP 26, p. 11 (1977).

3. 10 CFR 71.9(a).

cc: B. N. Odell
D. S. Myers
T. J. Powell
A. L. Partlow
R. L. Wilson